AN EVALUATION OF AN 18 INCH MINIMUM SIZE LIMIT AND TWO FISH BAG LIMIT FOR LARGEMOUTH BASS AT BALL LAKE

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ABSTRACT

Ball Lake was selected as a study lake for a quality largemouth bass management work plan (DFW work plan 95515) in 1995. As a result, an 18" minimum size limit and a two fish bag limit were instituted for largemouth bass at the lake in the fall of 1996. Periodic fish community surveys, angler creel surveys and largemouth bass population estimates were conducted to determine the effectiveness of these harvest restrictions. This report summarizes those efforts.

The total number of fish collected during the four general surveys at Ball Lake ranged from 555 to 1,121 fish and averaged 930. Bluegills and largemouth bass dominated the sport fish collections in all four of the general surveys. Both species responded favorably to the bass regulation change with increased densities of quality fish observed in the sample.

For 2008 weekends and weekdays combined at Ball Lake, anglers fished a total of 5,747 hours, approximately 55% on weekends, while harvesting 1,252 fish.

Total fishing pressure on weekends only from May through September during the four angler creel surveys at Ball Lake ranged from a low of 638 hours in 1996 to a high of 3,586 hours in 2002.

Bluegills dominated the harvested by number during these surveys, accounting for over 56% of the fish harvest annually.

Largemouth bass harvest was very low during the study period, less than 12 per year, but all were 18 in TL or larger. The number of bass caught and released sky rocketed from 42 in 1996 to 2,035 by 2008. Anglers specifically targeting bass also increased significantly and were in support of the new regulation.

There were no muskies harvested from Ball Lake in 2008. Anglers did, however, catch and released six legal size fish on weekends and weekdays combined. 2008 Ball Lake anglers were asked several questions to determine interest in muskie fishing at the lake. Approximately 99% of all anglers interviewed favored muskie stocking at Ball Lake while 11% of anglers were fishing exclusively for muskies. Approximately 15% of muskie anglers were satisfied with Ball Lake muskie fishing opportunities, 4% were satisfied, 4% were dissatisfied and 2% were very dissatisfied. The remainder (75%) were neutral.

The total largemouth bass population for Ball Lake more than doubled from 1995 to 2008 particularly for bass 14-18 in long. The number of 12.0 to 14.0 in TL bass increased from 0.8 per acre at the start of the project to 2.6 per acre in 2008 and the number of 14.0 to 18.0 in TL

bass increased from 0.8 per acre to 4.0 per acre. This met one of the objectives of the project, which was to increase the number of 14.0 to 18.0 in TL bass in Ball Lake to 4.0 bass per acre. Growth also slowed for bass in this size range as they lost approximately one inch of length by age 5. This is not totally unexpected considering the huge increase in bass abundance. Despite the increase in the number of 14.0 to 18.0 in TL bass, the objective of increasing the number of 18.0 in TL or larger bass in Ball Lake to 1.5 bass per acre was not met.

INTRODUCTION

Ball Lake is an 87 acre natural lake located approximately one mile west of Hamilton, Indiana in Steuben County. It has a maximum depth of 66 feet and an average depth of 40 feet. The inlet and outlet of Ball Lake is Fish Creek. The creek enters the lake on the west shore and leaves on the east shore, eventually draining into Ohio. The inlet portion of the creek is very susceptible to erosion from high water events. A flash flood in May 1996 severely damaged a gravel road which runs parallel to the creek and leads to the state owned public access site which is located on the west shore of Ball Lake. This road was rebuilt during the summer of 1996. A v-shaped steel sheet piling water control structure is located at the lake outlet. Approximately 90% of the shoreline is residentially developed with the remainder wooded.

Fish Creek, especially the lower portion, contains one of the most diverse populations of freshwater mussels in the Great Lakes Basin. The creek is home to thirty-one species of mussels. Three of these mussel species are federally endangered, including the last know population of the White Cat's Paw Pearly mussel.

Ball Lake was hydrographically surveyed in 1960. It was originally surveyed by fisheries biologist from the Indiana Department of Natural Resources, Division of Fish and Wildlife (DFW) in 1967 (Table 1). The purpose of the survey was to evaluate the sport fishery. Due to the abundance of rough fish and 3 to 5 inch bluegills, a total fish eradication project was recommended and carried out in the fall of 1968. The lake was restocked with smallmouth bass, rock bass and rainbow trout. A follow up survey conducted in 1969 showed positive results from the eradication. Although total eradication of rough fish was not achieved, an improved fishery was present. Additional general fish population surveys were conducted at Ball Lake in 1972, 1978, 1983, and 1988.

Ball Lake was stocked with rainbow trout on an annual basis from 1969 through 1982, but these stockings were discontinued due to declining water quality. The lake was initially stocked with tiger muskies in 1985 and these yearly stockings continued through 1996 (Table 2). Tiger muskie stockings statewide in Indiana were switched to purebred muskies in 1997, including Ball Lake. These stockings continue to date.

In August of 1996, an 18 inch minimum size limit for largemouth bass with a bag limit of two fish was implemented at Ball Lake as part of a quality largemouth bass management plan (DFW work plan 95515). The primary objectives of the regulation change was to increase the

largemouth bass density of 14 to 18 in TL fish to 4.0 bass/ac and that of bass 18 in TL or larger to 1.5 bass/ac. Additional objectives included increasing catch and release of all sizes of bass by 40% and bass 18 in TL or larger by 20%. In order to determine if the objectives were met, a study was initiated which included two general fish community surveys, three angler creel surveys and four bass population estimates. Two of the bass population estimates as well as one general fish community survey and one angler creel survey were conducted prior to the regulation changes in order to provide baseline data. In addition to the sampling conducted under the original work plan, two more general surveys as well as an additional bass population estimate were done. An angler creel survey, conducted under DFW work plan 300FW1F10D43616 for muskies, was also added in 2008. This creel called for surveying both weekdays and weekends as opposed to the three previous creels which were exclusively done on weekends. Due to variation in the length of the creel surveys and the number of days during a week sampled, only the weekend results for the months of May through September will be used when comparing all four creel surveys in this report. Also, in 2007 bass were collected in the spring by electrofishing to determine catch rates and obtain additional age and growth information. The results of these surveys will be outlined in this report and the impacts of the new regulations on the bass population as well as the entire Ball Lake fish community will be discussed.

METHODS

Four general fish community surveys were conducted at Ball Lake during the study, taking place in 1996, 2001, 2004 and 2008. Several physical and chemical characteristics of the water were measured in the deepest area of the lake. Measurements in 1996 followed acceptable DFW guidelines that were in place at that time, while the 2001, 2004 and 2008 measurements were done in accordance with the Manual of Fisheries Survey Methods (2001) standard lake survey guidelines. Submersed aquatic vegetation was sampled in 2001 using a transect method developed by DFW biologists. In 2004 and 2008, vegetation sampling followed guidelines written by Pearson (2004). A global positioning system (GPS) device was used to record the location of the limnological data collection site, aquatic vegetation sample sites, and fish collection sites in 2004 and 2008.

Fish were collected using pulsed D.C. electrofishing along the shoreline at night with two dippers for 1.0 hour in both 1996 and 2001 and for 0.75 hours in 2004 and 2008. Trap net effort consisted of 4 lifts in 1996, 2 lifts in 2001 and 3 lifts in 2004 and 2008. Two experimental-mesh gill nets were fished overnight for two nights in 2001 while three nets were fished overnight for two nights in 1996, 2004 and 2008. All fish collected were measured to the nearest 0.1 in TL. In addition, all fish were weighed to the nearest 0.01 pound in 1996. Length-weight regression equations for Fish Management District 2 were used to estimate the weight of all fish within the sample in 2001, 2004 and 2008. Five scale samples per half-inch group were collected from game species for age and growth analysis. Average length-at-age for these species was estimated using the Fraser-Lee method of back calculation and standard intercepts (DeVries and Frie 1996, Carlander 1982).

The Ball Lake angler creel surveys were conducted in 1996, 2001, 2002 and 2008. The 1996, 2001 and 2002 surveys were conducted on weekends only. In 2008, the creel survey was expanded to included weekdays and weekends in conjunction with a statewide project to evaluate muskie stockings. The 1996 survey ran from April 14 through September 29, the 2001 survey from May 1 through September 30, the 2002 survey from May 1 through October 31 and the 2008 survey from April 27 through October 31. The main parameters measured during the surveys included fishing pressure, fish harvest and species preference of anglers. Two fishing periods were used for these surveys, a morning period and an afternoon period. In 1996, the morning period began at 6:00 am and ended at 2:00 pm while the afternoon period began at 2:00 pm and ended at 10:00 pm while in 2001 and 2002 the morning period began at 6:30 am and ended at 2:00 pm while the afternoon period began at 2:00 pm and ended at 9:30 pm. For the 2008 creel, the morning period began at 7:30 am and ended at 3:00 pm while the afternoon period began at 3:00 pm and ended at 10:30 pm. The time in 2008 was adjusted from the previous surveys due to a change in most of the counties in Indiana from Eastern Standard Time to daylight savings time. Angler counts were conducted four times a day and anglers were interviewed as they completed their trip. In addition, any anglers still fishing when the clerk finished his shift were interviewed and noted as partial trips. Information collected from anglers included number of hours fished, number of fish harvested by species and length of fish harvested. The number of muskies (or tiger muskies) and largemouth bass caught and released by anglers was also recorded. Additional information collected included species preference,

county of residence, opinion regarding the quality of the Ball Lake fishery and satisfaction with that days fishing trip. In determining statistics for muskie anglers, it was decided to include anglers who indicated they were fishing exclusively for muskies as well as those who indicated they were fishing for bass and muskies together. Since it was not possible to separate the hours fished for muskies from the hours fished for bass for the latter group, it was considered that all of the hours were spent fishing for both species. Therefore, these hours were included in the muskie fishing effort. There was sufficient data from anglers fishing specifically for bass for comparison purposes so the effort from anglers fishing for bass and muskies together was not included in the bass analysis. In 2001 and 2002 anglers were asked if they were in favor of the 18" minimum and two fish bag limit for largemouth bass at Ball Lake. Anglers in 2008 were asked if they favored muskellunge stockings at Ball Lake and how they would rate their muskie fishing satisfaction at the lake. The data was expanded separately by month and by boat and shore fisherman. Holidays were included with the weekend periods. Pounds of fish harvested were calculated using regional length-weight regression equations.

Largemouth bass population estimates were conducted at Ball Lake in the spring of 1995, 1996, 2001, 2002 and 2008. Sampling effort each year consisted of three nights of pulsed D.C. electrofishing using two dippers. The entire shoreline was covered each night. Only largemouth bass were collected and all of these fish were measured to the nearest 0.1 in TL and marked by removing a fin. The number of bass that were re-captured on subsequent nights was recorded and a population estimate was made using the Schnabel method. In addition to the population estimates, spring electrofishing was conducted at Ball Lake in 2007 to determine catch rates of largemouth bass. Procedures similar to those used during population estimate sampling were used with the exception of removing a fin. Analysis of largemouth bass abundance concentrated on stock size (≥8 in TL) fish, which is the main size group used for comparative purposes in scientific literature. In addition, fish smaller than stock size are often times less vulnerable to our gear and therefore are collected in low numbers, making recapture difficult which in turn results in unreliable estimates of abundance.

RESULTS

The Secchi disk reading at Ball Lake during the 2008 general survey was 12.5 feet. Dissolved oxygen concentrations were adequate for fish survival above 17 feet. A total of 40 sites were randomly sampled during the 2008 plant survey, all of which fell within the littoral

zone in water 10 ft in depth or less. A total of 7 native and 1 exotic species was collected. Aquatic plants were observed at 39 of the 40 littoral sites sampled. The maximum number of plant species found at one site was four and the mean was two. Eurasian watermilfoil, an exotic invasive species, dominated the plant population as it was collected at 34 of the 39 sites that yielded plants. Other submersed species included coontail, slender naiad, small pondweed, chara, water stargrass and variable pondweed. One other species, sago pondweed, was observed during the survey was not collected at any of the sample sites. Five emergent, floating or floating leaf plants associated with wetlands, including cattails, pickerelweed, soft rush, spatterdock and white water lily, were also observed. For the previous three surveys, in addition to the submersed species found in 2008, curly-leaf pondweed, elodea and flat-stem pondweed were observed.

A total of 555 fish representing 18 species was collected during the 2008 general fisheries survey at Ball Lake. The dominant species numerically was gizzard shad (57%) followed by bluegill (20%) and largemouth bass (10%). Shad was also the number one species collected by weight (47%) followed by largemouth bass (26%), bluegill (6%) and white sucker (5%). The total number of fish collected during the other three general surveys at Ball Lake during this study (1996, 2001 and 2004) ranged from 992 to 1,121. Fourteen species were represented in the 2001 sample while 18 species were collected in 2004 and 21 in 1996. Bluegills and largemouth bass dominated the sport fish collections while crappies (both white and black) and yellow perch also contributed. Other sport species collected during these surveys included tiger muskie, muskellunge, northern pike, redear, and rock bass.

Gizzard shad was the dominant species collected in 2008 both by number (57%) and weight (47%). They ranged in length from 9.2 to 13.4 in TL and averaged 10.3 in TL. Previously, shad was the top species collected numerically in all but the 1996 survey where bluegill dominated. Shad were first found in Ball Lake in 1983.

Bluegills ranked second numerically in 2008 (20%) and were third by weight (6%). They ranged in length from 2.3 (age 1) to 7.8 (age 6) in TL and averaged 5.1 in TL. Harvestable size bluegills (6 in TL or larger) comprised 43% of the sample, reaching this size in their third or fourth year, while 7 in TL or larger fish comprised 12% and reached this size in their fifth year. Electrofishing yielded a catch of 49 bluegills per hour while 4/lift were collected during gill netting and 15/lift were caught in trap nets. Bluegill size structure was evaluated using

Proportional Stock Density (PSD) and Relative Stock Density (RSD) (Gabelhouse 1984). PSD is the proportion of stock length fish which are also quality length. RSD is the proportion of stock length fish which are also a specific length. The stock size for bluegills is 3 in TL while the quality size is 6 in TL. Electrofishing catch only was used when computing these indices. RSD was calculated for individuals measuring 7 in TL or larger. Bluegill PSD in 2008 was 33.3 while RSD-7 was 19.4. Bluegill PSD averages 31.7 for Indiana natural lakes while RSD-7 averages 15.0. Murphy and Willis (1996) recommended a bluegill PSD of 20-60 and a RSD-8 of 5-20 for a balanced fishery. Since there were no 8 in TL or larger bluegills collected from Ball Lake in 2008, RSD-8 was zero.

Bluegills were first in abundance among sport species collected in 1996 and 2004 and ranked second in 2001. Of the 486 bluegills collected in 1996 only 6.2% measured 6.0 in TL or larger, considered harvestable size (Table 3). The percentage of harvestable size bluegills collected jumped to 66% in 2001 although there were only 61 fish total in the sample. In 2004 41% of the bluegills collected were harvestable size. The largest bluegill captured during the 1996 survey measured 7.9 in TL and in 2001 measured 7.6 in TL. In the 2004 survey the largest bluegill measured 8.1 in TL. Bluegill PSD was 10.9 in 1996, 32.4 in 2001 and 39.5 in 2004. RSD-7 measured 3.7 in 1996, 8.8 in 2001 and 6.7 in 2004. RSD-8 for all years was less than 1.0. Electrofishing catch rates for bluegill were quite variable over the course of these three surveys. A total of 210 bluegills per hour was collected in 1996, 45 per hour in 2001and 121 per hour in 2004. The natural lakes average for bluegill electrofishing catch during general fisheries surveys is 394 fish per hour. Bluegill growth rates exhibited little change over the course of the three surveys, remaining average for northern Indiana natural lakes (Appendix 1).

A total of 56 largemouth bass weighing 66 pounds was collected in 2008. Bass comprised 10% of the sample numerically and 26% by weight, ranking them third and second in those categories respectively. They ranged in length from 4.5 (age 1) to 18.8 (age 8) in TL and averaged 12.1 in TL. Bass were collected at a rate of 69/hr during electrofishing and 1/lift was caught gillnetting. Bass 14 in TL or larger comprised 38% of the total bass sample in 2008 while 16 in TL or larger fish comprised 14% and 18 in TL or larger fish 7%. Age-2, 3 and 4 bass grew at an above average rate for northern Indiana natural lakes while all other ages grew at an average rate.

Largemouth bass collections over the course of the other three general surveys ranged from 77 to 82 fish. Bass 14 in TL or larger comprised only 3.9% of the total bass sample in 1996, which was prior to the imposition of the quality bass regulations. In 2001, six years following the start of the new regulations, the percentage of bass 14 in TL or larger in the sample jumped to 26.8% while in 2004 16.7% of the bass collected fell into this size range. The largest largemouth bass collected during these general surveys was a 20.7 in TL fish in 2004. The largest bass collected in 1996 measured 19.1 in TL and in 2001 it was 18.0 in TL. Bass growth at Ball Lake was average to above average in these three surveys (Appendix 2). However, age-5 bass were approximately 1.5 inches smaller in 2008 than those in 1995.

During the 2008 Ball Lake creel survey, anglers fished a total of 5,747 hours while harvesting 1,252 fish or 0.22 fish/hr (Table 4). Bluegill was the dominant species harvested (78%) followed by crappies (19.3%). No other species comprised more than 1% of the total harvest. Approximately 55% of the total fishing pressure was exerted on weekends. In addition, 53% of the total fish harvest occurred on weekends along with 58% of the largemouth bass catch and release. Total fishing pressure on weekends from May through September in 2008 was 2,977 hours and resulted in the harvest of 654 fish (Table 5). Fish were harvested at a rate of 0.22 fish/hr and anglers exerted 34 hours of pressure/ac. As in the complete survey, bluegill and crappie were the top two species harvested at 85% and 13% respectively.

Total fishing pressure on weekends from May through September for the previous surveys ranged from a low of 638 hours in 1996 to a high of 3,586 hours in 2002, while the fishing pressure in 2001 measured 3,429 hours. Anglers at Ball Lake harvested 182 fish in 1996, 1,636 fish in 2001and 2,256 in 2002. The number one species harvested by number in all three creel surveys was bluegill followed by crappie. Largemouth bass were highly sought by anglers but harvest was very low. There were six other species observed in the harvest including rock bass, pumpkinseed, yellow perch, redear, warmouth and bullhead. The largest contributors to the total harvest among these species were rock bass and perch.

Bluegills were the dominant fish harvested by number during the 2008 survey as 553 were taken on weekends accounting for 85% of the total fish harvest. Approximately 90% of the bluegill harvest was comprised of 6.0 in TL or larger fish while 40% were 7.0 in TL or larger (Table 6). They were harvested at a rate of 0.18/hr in 2008 and 6.5/ac.

Bluegills accounted for 67% of the total fish harvest in 1996, 56% in 2001 and 65% in 2002. The number of bluegills measuring less than 6 in TL ranged from 1% to 2% of the bluegill harvest during the three previous creel surveys. Seven-in TL and larger bluegills comprised 47% of the bluegill harvest in 1996, 62% in 2001 and 58% in 2002. Bluegills were harvested at a rate of 0.19 fish/hr and only 1.4/ac in 1996 prior to the imposition of the quality bass regulations. Following the regulation changes, bluegills were harvested at a rate of 0.27 fish/hr in 2001 and 0.41 fish/hr in 2002. The corresponding harvest rates in terms of fish/ac were 10.6 and 16.8. On average, small size natural lakes in Indiana (less than 100 acres) have yielded 0.70 bluegills/hr and 138/ac during the past 28 years. This is based on the results of 13 small sized natural lakes that have been creeled since 1978.

Both black and white crappies are present in Ball Lake and were lumped together for analysis. Crappies were second in abundance among fish harvested in 2008. They comprised 19% of the total fish harvest and 13% of the weekend harvest from May through September. Approximately 89% of the crappies measured 8.5 in TL or larger, which is considered harvestable size and the largest measured 13.5 in TL (Table 7). Over the course of the other three surveys crappies ranked second in abundance in the harvest each year. The overall abundance of crappies at Ball Lake has been variable over the years, not unlike many other Indiana natural lakes. Harvest ranged from 54 crappies in 1996 to 481 in 2001 and averaged 267, with fish up to 14.0 in TL being caught. Crappies can provide good angling opportunities at Ball Lake at times.

Largemouth bass harvest was very low in 2008 as only 14 bass were taken. Eleven of these were harvested on weekends from May through September. All of the bass harvested were 18 in TL or larger (Table 8). Catch and release of bass totaled 3,711 fish of which 2,747 were caught on weekends from May through September. The total Ball Lake bass catch in 2008 (harvest plus catch and release) totaled 3,725 fish or 0.65 bass/hr. Catch on weekends from May through September totaled 2,040 fish or 0.69/hr. During the three previous surveys, only four bass were taken in 1996, two in 2001and 12 in 2002. In addition, 42 bass were caught and released in 1996 along with 964 in 2001 and 1,057 in 2002 (Table 9).

Fishing pressure by anglers specifically seeking bass at Ball Lake in 2008 totaled 1,999 hours with 1,057 of these occurring on weekends from May through September. These anglers caught 2,845 (1.48/hr) and 1,632 bass (1.55/hr) respectively. Approximately 46.5% of all

anglers interviewed in 2008 were fishing specifically for bass and exerted a fishing pressure of 13.06 hours/ac. From May through September, bass anglers fished 79 hours in 1996, 602 hours in 2001 and 616 hours in 2002 (Table 10). This group accounted for 13.9% of all anglers interviewed in 1996 along with 16.2% of the 2001 anglers and 16.8% of the 2002 anglers. They exerted fishing pressures of 0.91, 6.92 and 7.09 hours per acre in 1996, 2001 and 2002 respectively while catching bass at a rate of 0.13 fish per hour in 1996, 0.72 per hour in 2001 and 0.62 per hour in 2002. The average catch rate for largemouth bass in Indiana natural lakes is 1.02 fish per hour.

In 2008, a major component of the creel survey involved evaluating the muskie fishery at Ball Lake. Approximately 11% of the anglers interviewed at Ball Lake on weekdays and weekends combined indicated they were fishing exclusively for muskies while an additional 10% were fishing for muskies in combination with largemouth bass. Muskie fishing pressure at Ball Lake in 2008 totaled 1,160 hours with 597 hours occurring on weekends (Table 11). Weekend muskie anglers at Ball Lake fished 123, 400 and 982 hours in 1996, 2001 and 2002 respectively. Muskie anglers failed to catch a muskie at Ball Lake during the 2008 survey. There was one observation by the creel clerk of a legal size muskie being caught and released at Ball Lake in 2008 but this fish was taken by a party fishing for bass. The observed muskie catch at Ball Lake during the four creel surveys, including tiger muskies, totaled 28 fish. Expanding this number based on total fishing effort yielded an estimate of 58 muskies caught. Only four of the 28 observed muskies caught were taken by anglers fishing specifically for muskie (Table 12). Eleven muskies were caught by anglers fishing for bass and muskies, seven were caught by anglers fishing for anything, five were caught by bass anglers and one by an angler fishing for crappies.

Muskie anglers were asked several questions specific to muskie fishing at Ball Lake in 2008. Since these questions were not asked in the previous creel surveys, the answers from both weekend and weekday anglers are included. Muskie stocking is popular at Ball Lake as 99% of the anglers interviewed indicated they favored the stockings. Muskie anglers were also asked to rate their satisfaction with muskie fishing at Ball Lake. Approximately 38% indicated they were satisfied and an additional 19% said they were very satisfied with muskie fishing at Ball Lake. Dissatisfied anglers comprised approximately 19% of the sample and 5% were very dissatisfied The remainder (19%) were neutral.

Anglers fishing specifically for bass (46.5%) represented the largest percentage of anglers interviewed on weekends in 2008 followed by those fishing for anything they could catch (18%) (Table 13). Bluegill anglers comprised the next highest percentage (13%) followed by muskie anglers (10%), then those fishing for bass and muskies (8%). The majority of anglers in 1996 indicated they were fishing for anything (60%). This was the top category in 2001 and 2002 also. Anglers fishing for bass ranked second in all three of the previous surveys. Only 1% of the anglers interviewed in 1996 were fishing for bluegills, 4% in 2001 and 7.5% in 2002.

Ball Lake anglers in 2008 were asked to rate fishing for the particular species they were fishing for that day. Approximately 73% responded that they thought it was good and only 12% rated it as poor. Just over 16% of anglers interviewed in 1996 thought fishing in general at Ball Lake was improving while in 2001 and 2002 approximately 45% of the anglers said that they thought fishing was improving.

There were no questions in the 2008 creel survey specific to bass fishing due to the emphasis on muskie fishing. During the 2001 and 2002 surveys, anglers were asked if they approved of the 18" size limit for largemouth bass. Approximately 69% of the anglers interviewed responded that they strongly supported the new size limit. In 2002 anglers were asked if they thought the new size limit had improved bass fishing at Ball Lake. Approximately 55.6% of the anglers strongly agreed and 29.1% said they somewhat agreed that the new size limit had improved bass fishing while only 4.5% disagreed with that statement.

Steuben County residents (25%) comprised the largest contingent of Ball Lake anglers in 2008 (Table 14) followed by DeKalb County (24%) and Allen County (20%) residents. In all, anglers from 10 Indiana counties as well as from out of state fished at the lake in 2008. When including lake residents, the percentage of Steuben County anglers increases to 42%. Lake residents by themselves ranked fourth among angling groups by number in 2008, first in 2002 and second in 2001.

The total largemouth bass population at Ball Lake in 2008 was estimated at 1,087 fish. The estimated number of stock size bass (8.0 in TL or larger) present was 1,002 fish while the estimate for bass 14 .0 to 17.5 in TL was 350 fish (Table 15). There were 13 bass measuring 18.0 in TL or larger estimated to be present in Ball Lake in 2008. In terms of number of bass present in relation to the lake size, estimates for the three aforementioned size ranges were 11.5, 4.0 and 0.2 bass/ac respectively (Table 16).

An average of 172.1 bass/hr was collected from Ball Lake during spring electrofishing in 2007 and 2008 (Table 17). Bass 14.0 in TL or larger were collected at an average rate of 64.5/hr per hour while bass 18.0 in TL or larger were captured at an average rate of 2.5/hr.

PSD for Ball Lake largemouth bass was calculated as well as RSD's for bass measuring 14.0 in TL or larger, 15.0 in TL or larger and 18.0 in TL or larger (Table 18). The resultant values in 2008 were 59.2, 36.2, 19.4 and 1.3 respectively.

The total largemouth bass population at Ball Lake in 1995 was estimated at 507 fish, while the estimate was 398 bass in 1996, resulting in an average of 453 bass for those two years. This was prior to the imposition of the quality bass harvest regulations. Estimates of stock size bass were 332 bass in 1995 and 326 bass in 1996 for an average of 329 (3.8/acre). The number of 14 .0 to 17.5 in TL bass was estimated at 116 in 1995 and 18 in 1996, an average of 67. This resulted in an estimate of 0.8 bass/ac of this size group present in Ball Lake for the two pre-quality bass regulation years. There were an estimated 11 bass measuring 18.0 in TL or larger present in Ball Lake in 1995 and 2 in 1996 for an average of 7 fish (0.08/acre). Catch per hour of stock size largemouth bass at Ball Lake during spring electrofishing in 1995 and 1996 averaged 53.4 bass/hr. Bass 14.0 in TL or larger were collected at a rate of 10.8/hr while those 18.0 in TL or larger were captured at a rate of 1.0/hr. The population estimate for all bass in 2001and 2002 was 1,593 and 1,769 fish respectively. The average number of stock size bass estimated in the first two post-quality regulation surveys (2001 and 2002) was 1,381 fish or 15.9/ac. Estimates of bass 14 .0 to 17.5 in TL were 317 fish in 2001 and 187 in 2002, an average of 252 bass or 2.9/ac. Bass measuring 18.0 in TL or larger in 2001 and 2002 were estimated to number on average 23 fish or 0.3/ac. The average for small natural lakes in Indiana is 1,621 stock size bass per lake (19.3/acre), with an average of 1.9 bass/ac ranging from 14 .0 to 18.0 in TL and 0.7 bass/ac measuring 18.0 in TL or larger. An average of 185.1 stock size bass/hr was collected during spring electrofishing in 2001 and 2002. Bass 14.0 in TL or larger were collected at an average rate of 37.5 fish/hr and those 18.0 in TL or larger were captured at an average rate of 3.3/hr.

Largemouth bass PSD at Ball Lake for 1995 and 1996 averaged 43.4 while the average for 2001 and 2002 was 34.8. The 1995-96 average for RSD-14 was 22.2, similar to the 2001-02 average of 20.4. RSD-15 and RSD-18 averaged 12.3 and 2.0 respectively for the 1995-96 surveys and 13.7 and 2.0 for the 2001-02 surveys. For a balanced fishery, Anderson (1980)

suggests largemouth bass PSD and RSD-15 of 40-70 and 10-25 respectively while Murphy and Willis also recommended a largemouth bass PSD of 40-70 with a RSD-15 of 10-40.

DISCUSSION

The primary purpose of this project was to determine the effects of more restrictive harvest regulations for largemouth bass on the bass population and fish community of Ball Lake. In addition, changes in the number of bass caught and released were measured as well as changes in angler participation in bass fishing. Angler attitudes in regards to fishing quality at Ball Lake and the special bass harvest restrictions were also determined. Finally, changes in bluegill size structure and abundance following implementation of the bass harvest restrictions were evaluated.

The largemouth bass population responded positively to the new harvest restrictions as the estimated number of stock size bass increased three fold from 1995-1996 to 2008. In addition, the average number of 8.0 to 12.0 in TL bass doubled. The number of 12.0 to 14.0 in TL bass roughly tripled by 2008 and approximately five times as many 14.0 to 18.0 in TL bass were present. This indicates a good increase in recruitment of smaller bass into the 14.0 to 18.0 in TL size group occurred. This meets one of the project objectives, which was increasing the number of 14.0 to 18.0 in TL bass in Ball Lake to 4.0 bass/ac. An increase in abundance of bass 18.0 in TL or larger was also achieved, as this number doubled following the new regulations. However, the project objective of 1.5/ac was not achieved. Although there were positive changes in the largemouth bass size structure, reflected by increases in the number of bass 14.0 in TL or larger in the population, the total number of stock size fish in the Ball Lake population remained below average at 11.5 per acre compared to the 19.3 per acre average for small natural lakes statewide and abundance of 8.0 to 12.0 in TL bass seems to be in decline. PSD and RSD values had increased by 2008 with the exception of RSD-18 which declined slightly. Values fell within the ranges suggested by Anderson, as well as Murphy and Willis, that were indicative of balanced bass populations.

Weekend fishing pressure at Ball Lake increased substantially over the course of this investigation with a corresponding increase in bass fishing pressure occurring along with it. The harvest of largemouth bass was extremely low throughout the project, ranging from 2 to 12 fish/creel survey. However, along with the increase in fishing pressure, the number of bass

caught and released on weekends sky rocketed from 42 in 1996 to 1,041 in 2002, before nearly doubling to 2,026 in 2008. This easily exceeded the project objective of a 40% increase in the catch and release of bass. Total catch and release for 2008 (weekdays and weekends combined) was estimated at 3,711 bass. With an estimated total bass population of 1,087 fish, this means each bass was caught an average of 3.4 times. Despite the large increase in catch and release of bass, the average catch rate of bass at Ball Lake remains low compared to the small natural lakes average. Considering the overall low productivity of Ball Lake, as demonstrated by the low catch rates in both general surveys and creel surveys as well as lower than average population estimates, it is not realistic to expect average catch rates at lakes such as this.

The percentage of anglers fishing exclusively for largemouth bass increased slightly between 1996 and 2002, before showing a significant increase in 2008. This could be indicative of a very favorable response to the increase in the number of larger bass present in the lake. At the same time, the number of anglers who thought fishing was improving at Ball Lake jumped from 16% in 1996 to 45% in 2001 and 2002. Anglers in 2008, responding to a different wording of the question, indicated they were happy with the fishery at Ball Lake as six times as many anglers rated it as good compared to those rating it poor. Support for the new largemouth bass harvest regulations was high, as approximately 69% of the anglers interviewed responded that they strongly supported the new size limit. Correspondingly, the vast majority of anglers interviewed in 2002 thought the new size limit had a favorable impact on bass fishing at Ball Lake.

Despite falling short of the goal of increasing the abundance of bass 18.0 in TL or larger to 1.5 per acre, the overall impact of the toughened harvest restrictions on the largemouth bass population of Ball Lake has been good. Bass numbers have increased substantially and the response from bass anglers has been very positive as the popularity of the largemouth bass fishery at Ball Lake has risen. Questions remain as to the sustainability of the improvements in the bass fishery especially in lieu of declines in the growth rate of age-5 and older bass as well as the decrease in the number of 8.0 to 13.5 in TL fish in the population. Further investigations will be needed to determine if the declines in growth will impact abundance of larger bass.

Bluegills at Ball Lake continued to grow at an average rate for northern Indiana natural lakes throughout the course of this project. Electrofishing catch rates for bluegill were quite variable over the course of the four general surveys (45 to 210/hr). All catch rates were well

below the natural lakes average (394 fish/hr). The size structure of the bluegill population, however, showed improvement. In 1996 the percentage of bluegills collected during the general fish community survey measuring 6.0 in TL or larger was very low but in the three successive surveys averaged 50% of the sample. PSD as well as RSD-7 for bluegills has also improved, however RSD-8 continues to be very poor. Despite the improvement in the number of quality size bluegills in Ball Lake, few large bluegills (8.0 in TL or larger) are present. This is typical of lakes with large gizzard shad populations, which compete directly with bluegills for food. However the low abundance of large bluegills cannot be solely blamed on the presence of gizzard shad. It was not evident that shad had become overly abundant at Ball Lake until the 1983 general fisheries survey and in the three general fish community surveys at Ball Lake conducted prior to 1983, only one bluegill 8.0 in TL or larger was collected. The 1969 survey is excluded from this discussion because it immediately followed a total lake renovation in 1968. Obviously, other factors affecting maximum bluegill size are in play at Ball Lake. Despite the lack of larger bluegills in the population, they remain the most abundant fish harvested during creel surveys, ranging from 56% to 84% of the total number of fish harvested in a given year. Still, bluegill harvest at Ball Lake is extremely low compared to similar sized natural lakes in Indiana. During the best year of bluegill fishing in the four creels conducted (2002), bluegills were harvested at a rate of 0.41 fish/hr and 17/ac, substantially below the average for small Indiana natural lakes (0.70/hr and 138/ac). This again points to the low productivity of the lake.

The muskie fishing pressure and interest at Ball Lake is low. Only 11% of the anglers interviewed in 2008 at Ball Lake indicated they were fishing exclusively for muskies and they exerted only 645 hours of fishing pressure (7.41 hrs/ac). There were no legal size muskies harvested and only six were caught and released. Anglers indicated they favored the muskie stockings (99%), however few fished for them. Despite low catch rates for muskies, 57% of Ball Lake muskie anglers said they were satisfied or very satisfied with muskie fishing at the lake.

SUMMARY

Ball Lake has historically had management issues. It's elongated bowl shape, narrow littoral zone, summer water temperature and oxygen profile and the presence of gizzard shad have all contributed to the low productivity present. Since 2001 the bluegill size structure has improved. Bluegill PSD is now within the suggested range for a healthy population and the

number of harvestable size fish has increased. However, the overall population remains low in abundance with few 8.0 in TL or larger fish present and the overall bluegill harvest is well below average.

The largemouth bass population in Ball Lake, which has often exhibited weak or missing year classes over the years, has shown improvements in size structure since the implementation of the more stringent size and bag limits at the beginning of this project. The 2008 bass PSD and RSD-15 values are within the preferred range and the number of 14.0 in TL or larger bass has increased. Although total bass numbers remain below average for small natural lakes, bass fishing pressure and the number of bass caught and released have improved significantly. The present bass regulations are also strongly supported by anglers. There is some concern in regards to the decrease in the number of 8.0 to 11.5 in TL bass now present in the population. These fish are crucial in determining future recruitment of harvestable size bass. The decrease of growth for age-5 and larger bass is also a concern. This merits future monitoring of the bass population to determine if these declines are long term and pose a threat to the improved bass fishery.

Muskie fishing pressure and catch at Ball Lake is low and there is not much interest from anglers. After twenty-five years of stocking, it is difficult to justify the continuation of this expensive, hatchery dependent program at Ball Lake.

RECOMMENDATIONS

- The 18.0 in TL minimum size limit and two fish bag limit for largemouth bass at Ball Lake should remain in effect. Implementation of these harvest restrictions should be considered at other natural lakes where bass growth is above average and forage is abundant.

- A largemouth bass population estimate should be conducted at Ball Lake in 2013. Age and growth analysis should accompany this estimate.

- The muskie stocking program at Ball Lake should be discontinued.

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Table 1. Species composition and relative abundance of fish collected during 1967, 1969, 1972, 1978, 1983, 1988, 1996, 2001, 2004 and 2008 general fisheries surveys of Ball Lake.

Species	1967	1969	1972	1978	1983	1988	1996	2001	2004	2008
Black bullhead	1	2		3	11			2		2
Black crappie	6			34	34	23	121	20	47	17
Bluegill	149	24	95	95	63	42	486	61	376	109
Bluntnose minnow							7			
Brook silverside	C	C	C	C	S	S	C	C	C	C
Brown bullhead				4		2	2			
Brown trout				3						
Common carp	3	4	9	7	7	7	10	3	10	1
Fathead minnow									1	
Gizzard shad	10	2	14		213	263	56	764	460	317
Golden redhorse							1		2	
Green sunfish	4	4	2		1		10		6	3
Hybrid sunfish							1			2
Johnny darter	R									
Lake chubsucker		1	3		1					
Largemouth bass	44	114	69	100	170	39	77	82	78	56
Log perch	C				2	1	83	4		
Muskellunge								4	4	2
Northern hog sucker				6		3				
Northern pike		2	3	2	2	1		1		
Pumpkinseed	21	4	17	12	3	2	23		16	8
Quillback carpsucker				1		1				
Rainbow trout		56	1	11						
Redear						1	1			1
Redfin pickerel	1	10	3	3						
River carpsucker	1									
Rock bass	10	6	2	26	10	4	54	2	19	10
Smallmouth bass		10								
Spotted sucker	155	2	11	43	49	23	29		2	3

(Table 1 Cont.)

Species	1967	1969	1972	1978	1983	1988	1996	2001	2004	2008
Tiger muskie						23	15			
Warmouth	17	3	7	4		3			3	5
White crappie				20	12	13	24	1	4	
White sucker	2	17	16	11	82	31	4	4	11	11
Yellow bullhead	21		5	11	3		2		5	3
Yellow perch	47	55	13	14	7	11	46	44	77	5
Total	492	316	270	410	670	493	1,052	992	1,121	555
Sampling Effort										
Electrofishing Effort	2.0 h AC	2.0 h AC	2.0 h AC	2.0 h AC	1.0 h DC	1.0 h DC	1.0 h DC	0.75 h DC	1.0 h DC	.075 h DC
Gill Net Effort	8 lifts	6 lifts	4 lifts	16 lifts	9 lifts	6 lifts	6 lifts	4 lifts	6 lifts	6 lifts
Trap Net Effort	20 lifts*	3 lifts	0 lifts	8 lifts	4 lifts	4 lifts	4 lifts	2 lifts	3 lifts	3 lifts

C = Common R = Rare S = Scarce
*Wire traps

Table 2. Ball Lake tiger muskie and muskie stockings.

Date	Species	Number stocked	Ave. Size (in)	Number per acre
8/30/85	Tiger Muskie	704	8.9	8.1
9/10/86	Tiger Muskie	435	10.0	5.0
10/7/87	Tiger Muskie	441	10.4	5.1
10/13/89	Tiger Muskie	702	9.1	8.1
10/3/90	Tiger Muskie	696	10.5	8.0
10/16/91	Tiger Muskie	546	12.0	6.3
9/30/92	Tiger Muskie	700	10.3	8.0
10/6/93	Tiger Muskie	700	10.2	8.0
10/5/94	Tiger Muskie	712	10.4	8.2
10/11/96	Tiger Muskie	700	9.8	8.0
10/17/97	Muskie	700	8.8	8.0
10/28/98	Muskie	700	10.0	8.0
11/5/99	Muskie	700	11.9	8.0
11/14/00	Muskie	700	10.9	8.0
11/7/01	Muskie	700	11.2	8.0
10/31/02	Muskie	700	9.4	8.0
11/6/03	Muskie	700	9.5	8.0
11/10/04	Muskie	435	9.1	5.0
11/8/05	Muskie	435	9.4	5.0
11/1/06	Muskie	453	8.8	5.2
11/25/07	Muskie	87	9.0	1.0
11/22/08	Muskie	435	8.0	5.0

Table 3. Relative abundance by select size ranges for bluegill and largemouth bass collected during the 1967, 1969, 1972, 1978, 1983, 1988, 1996, 2001, 2004 and 2008 general fisheries surveys of Ball Lake.

Species	Length Range (TL)	1967	1969*	1972	1978	1983	1988	1996	2001	2004	2008
Bluegill	< 3.0 in	13	22	12	0	3	3	213	0	3	4
	3.0-5.5 in	134	0	71	69	51	30	243	21	220	72
	6.0-6.5 in	2	0	8	14	7	6	22	33	130	20
	7.0-7.5 in	0	2	3	12	2	3	7	7	21	13
	≥ 8.0 in	0	0	1	0	0	0	1	0	2	0
	PSD						8.3	10.9	32.4	39.5	33.3
	RSD-7						4.2	3.7	8.8	6.7	19.4
	RSD-8						0.0	0.2	0.0	0.5	0.0
	EF catch/hour						36.0	210.0	45.3	121.0	49.3
Largemouth bass	< 8.0 in	37	30	5	86	79	13	46	9	13	10
	8.0-9.5 in	3	83	32	6	33	5	12	28	21	6
	10.0-11.5 in	1	1	8	4	4	11	13	17	21	5
	12.0-13.5 in	2	0	18	1	30	4	3	6	10	14
	14.0-17.5 in	1	0	6	3	22	5	1	21	11	17
	≥ 18.0 in	0	0	0	0	2	1	2	1	2	4
	PSD						27.8	18.5	40.9	33.3	74.4
	RSD-15						2.8	11.1	15.2	9.5	27.9
	EF catch/hour						2.8	11.1	98.7	76.0	69.3

*This survey followed a total fish eradication and re-stocking project carried out in the fall of 1968.

Table 4. Monthly fishing pressure and harvest from Ball Lake, April to October, 2008.

Species	April	May	June	July	August	September	October	Total
Bluegill	0	109	122	344	365	0	35	975
Crappie	69	98	9	66	0	0	0	242
Largemouth bass	9	5	0	0	0	0	0	14
Rock bass	0	0	4	10	0	0	0	14
Yellow perch	0	4	0	0	0	0	0	4
Warmouth	0	0	0	0	0	0	2	3
Total	69	220	140	420	365	0	38	1,252
Angler hours	268.00	1,289.64	976.20	1,239.00	1,190.40	423.09	360.36	5,746.69
Hours per acre	3.08	14.82	11.22	14.24	16.68	4.86	4.14	66.05
Fish per hour	0.26	0.17	0.14	0.34	0.31	0.00	0.11	0.22

Table 5. Fish harvest and yield during weekends from May to September 1996, 2001, 2002 and 2008 creel surveys of Ball Lake.

Species	1996		2001		2002		2008	
	Number Harvested	Total Weight (lbs.)	Number Harvested	Total Weight (lbs.)	Number Harvested	Total Weight (lbs.)	Number Harvested	Total Weight (lbs.)
Bluegill	122	28.54	918	239.88	1,426	355.75	553	125.27
Largemouth bass	4	26.00	2	8.20	12	37.44	11	32.45
Crappie	54	14.19	481	267.61	267	124.44	85	67.52
Rock bass	2	0.70	3	0.94	182	50.52	5	1.89
Pumpkinseed			9	2.31	37	7.28		
Yellow perch			186	96.59	236	56.53		
Redear			29	12.11	13	3.33		
Bullheads			8	3.40	43	28.61		
Total	182	69.43	1,636	631.04	2,216	673.91	654	227.13
Angler hours	581.79		3,429.15		3,436.70		2,977.00	
Hours per acre	6.69		39.42		39.50		34.29	
Fish per hour	0.31		0.48		0.64		0.22	

Table 6. Length-frequency distribution for bluegills harvested on weekends from May to September during 1996, 2001, 2002 and 2008 creel surveys of Ball Lake.

Total Length (in.)	1996	2001	2002	2008
5.0	3	13		6
5.5		8	15	47
6.0	62	101	197	83
6.5		224	379	183
7.0	32	255	429	127
7.5		210	315	95
8.0	21	75	91	6
8.5	2	32		
9.0	2			6
Total	122	918	1,426	553

Table 7. Length-frequency distribution for crappies harvested on weekends from May to September during 1996, 2001, 2002 and 2008 creel surveys of Ball Lake.

Total Length (in.)	1996	2001	2002	2008
6.0	10			
7.0	4		35	
7.5		7	22	
8.0	8	29	41	
8.5		34	30	7
9.0		54	11	
9.5		83	14	
10.0	24	111	25	
10.5		72	16	
11.0	2	37	38	21
11.5		13	22	21
12.0	2	11	5	36
12.5		13	5	
13.0		7	3	
13.5		9		
14.0	4	4		
Total	54	481	267	85

Table 8. Length-frequency distribution for largemouth bass harvested on weekends from May to September during 1996, 2001, 2002 and 2008 creel surveys of Ball Lake.

Total Length (in.)	1996	2001	2002	2008
18.0		1	6	11
18.5			6	
19.0	3	1		
19.5	1			
Total	4	2	12	11

Table 9. Estimated catch and release of largemouth bass on weekends from May to September during 1996, 2001, 2002 and 2008 creel surveys of Ball Lake.

Size	1996	2001	2002	2008	Total
Sub-legal bass	NA	NA	NA	1,957	
Legal bass	NA	NA	NA	69	
Total	42	964	1,041	2,026	4,073

Table 10. Creel survey estimates of bass fishing statistics for anglers fishing exclusively for largemouth bass at Ball Lake on weekends from May to September, 1996, 2001, 2002 and 2008.

Year	Percentage of LMB anglers	LMB Fishing Pressure (hrs)	LMB Fishing Pressure (hrs/ac)	LMB Harvest	LMB <18" C&R	LMB ≥18" C&R	Total LMB C&R	LMB catch/hr
1996	13.9	76.06	0.87	2	NA	NA	8	0.13
2001	16.2	602.08	6.92	2	NA	NA	430	0.72
2002	16.8	594.82	6.84	0	NA	NA	369	0.62
2008	46.6	1,056.74	12.15	6	1,563	69	1,632	1.54
2008*	38.6	1,858.35	21.36	9	2,644	103	2,747	1.49

*Includes weekdays.

Table 11. Creel survey estimates of muskie fishing statistics on weekends at Ball Lake, 1996, 2001, 2002 and 2008.

Survey Dates	MUE Fishing Pressure* (hrs)	MUE Fishing Pressure* (hrs/ac)	MUE Catch by MUE Anglers*	Other MUE Catch	Total MUE Catch	% fishing for MUE	% satisfied or very satisfied
4/14 - 9/30/96	123.15	1.42	9	14	23	18	NA
5/1 - 9/30/01	399.56	4.59	8	9	17	4	NA
5/1 - 10/31/02	981.56	11.28	14	0	14	14	NA
4/27 - 10/31/08	597.22	6.86	0	1	1	10	72.7
4/27 - 10/31/08**	1,159.88	13.33	0	1	1	11	63.5

*Includes anglers fishing for muskies or bass and muskies.
**Includes weekdays.

Table 12. Observed muskie catch by angler species preference category at Ball Lake, 1996, 2001, 2002 and 2008.

	Muskie Catch				
Species Preference	1996	2001	2002	2008	Total
Anything	7				7
Bass	1	3		1	5
Crappie		1			1
Muskie	2	1	1		4
Bass & Muskie	4	3	4		11
Total	14	8	5	1	28

Table 13. Species preference of Ball Lake anglers by percent on weekends from May to September, 1996, 2001, 2002 and 2008.

Species Preference	1996	2001	2002	2008	Average
Anything	60.0	47.7	36.4	18.2	40.6
Bass	13.9	16.2	16.8	46.5	23.4
Bluegill	1.0	4.1	7.5	13.1	6.4
Crappie	5.0	1.7	3.7	4.0	3.6
Muskie	12.9	4.1	12.6	10.1	9.9
Panfish	1.0	0.4	2.3		1.2
Yellow perch		1.2			1.2
Bass & bluegill	1.0	9.5	2.8		4.4
Bass & muskie	4.0	7.1	11.7	8.1	7.7
Bass & panfish	1.0	2.9	3.3		2.4
Bluegill & crappie		4.1	2.8		3.5
Crappie & perch		0.8			0.8

Table 14. County of residence by percent for anglers fishing at Ball Lake in 1996, 2001, 2002 and 2008.

	1996	2001	2002	2008
Lake resident		20.4	28.3	17.6
Adams		11.1	1.8	0.4
Allen	13.4	12.9	14.6	19.7
Dearborn		0.4		
Decatur		0.4	0.4	
DeKalb	18.8	10.2	18.1	24.4
Delaware			1.8	
Hamilton				0.4
Huntington	4.5			0.4
LaGrange	0.9		1.3	1.3
LaPorte			0.4	
Madison			0.9	
Marion				0.4
Noble	3.6	0.4	0.4	0.4
Ohio		7.6	6.2	
St. Joseph	0.9			
Steuben	38.4	36.4	25.7	24.8
Wells	0.9			
Whitley				0.4
Out of State	18.8			9.6

Table 15. Schnabel population estimates by select size ranges for largemouth bass at Ball Lake collected in 1995, 1996, 2001, 2002 and 2008.

Length Range (TL)	1995	1996	2001	2002	1995, 1996 Average*	2001, 2002 Average	2008	Small NL Average
8.0-11.5 in	92	279	893	927	186	910	409	1,154
12.0-13.5 in	113	27	116	286	70	201	230	306
14.0-17.5 in	116	18	325	169	67	247	350	161
≥ 18.0 in	11	2	22	24	7	23	13	61
Total (stock size)	332	326	1,356	1,406	330	1,381	1,002	1,682

*Prior to bag and size limit change

Table 16. Schnabel population estimates of the number of largemouth bass per acre by select size ranges at Ball Lake in 1995, 1996, 2001, 2002 and 2008.

Length Range (TL)	1995	1996	2001	2002	1995, 1996 Average*	2001, 2002 Average	2008	Small NL Average
8.0-11.5 in	1.1	3.2	10.3	10.7	2.2	10.5	4.7	13.2
12.0-13.5 in	1.3	0.3	1.3	3.3	0.8	2.3	2.6	3.5
14.0-17.5 in	1.3	0.2	3.7	2.0	0.8	2.9	4.0	1.9
≥ 18.0 in	0.1	0.1	0.3	0.3	0.1	0.3	0.2	0.7
Total (stock size)	3.8	3.8	15.6	16.3	3.9	16.0	11.5	19.3

*Prior to bag and size limit change

Table 17. Catch per hour by select size ranges for largemouth bass collected during 1995, 1996, 2001, 2002, 2007 and 2008 spring electrofishing surveys of Ball Lake.

Length Range (TL)	1995	1996	2001	2002	2007	2008
≥ 8.0 in	45.83	60.89	211.06	159.07	164.48	179.78
≥ 14.0 in	17.50	4.00	53.18	21.86	63.80	65.11
≥ 18.0 in	1.50	0.44	3.76	2.74	2.70	2.22

Table 18. PSD and select RSD values for the estimated largemouth bass population at Ball Lake in 1995, 1996, 2001, 2002 and 2008.

	1995	1996	2001	2002	1995, 1996 Average*	2001, 2002 Average	2008
PSD	72.3	14.4	33.8	35.7	43.4	34.8	59.2
RSD-14	38.3	6.1	25.3	15.4	22.2	20.4	36.2
RSD-15	20.5	4.0	17.1	10.3	12.3	13.7	19.4
RSD-18	3.3	0.6	1.9	2.1	2.0	2.0	1.3

*Prior to bag and size limit change

APPENDIX 1. Age and growth tables for bluegills at Ball Lake, 1996, 2001, 2004 and 2008.

	Length (inches) at last annulus formation at each age							
Survey Year	1	2	3	4	5	6	7	8
1996	2.2	3.5	4.7	6.0				
2001	2.5	3.4	4.9	5.6	6.5			
2004	2.2	3.4	5.0	6.3	6.5	7.2		
2008	2.2	3.2	4.6	5.1	6.7	7.4		
Natural Lakes Average	1.7	3.1	4.7	6.1	6.9	7.4		

1996

Year Class	Number Aged	Back calculated length (inches) at each age							
		1	2	3	4	5	6	7	8
1995	5	2.2							
1994	11	2.0	3.5						
1993	9	1.8	3.3	4.7					
1992	5	1.6	3.3	4.9	6.0				
Average Length		1.9	3.4	4.8	6.0				
Standard Deviation		0.22	0.09	0.10					
Number Averaged		30	25	14	5				

2001

Year Class	Number Aged	Back calculated length (inches) at each age							
		1	2	3	4	5	6	7	8
2000	2	2.5							
1999	1	1.7	3.4						
1998	15	1.8	3.4	4.9					
1997	5	1.6	2.9	4.5	5.6				
1996	3	1.7	3.0	4.7	6.0	6.5			
Average Length		1.7	3.1	4.7	5.8	6.5			
Standard Deviation		0.08	0.24	0.18	0.22				
Number Averaged		23	23	23	8	3			

2004

Year Class	Number Aged	Back calculated length (inches) at each age							
		1	2	3	4	5	6	7	8
2003	3	2.2							
2002	15	1.9	3.4						
2001	16	1.7	3.3	5.0					
2000	5	1.6	3.4	5.0	6.3				
1999	1	1.3	3.1	4.7	5.9	6.5			
1998	5	1.5	3.0	4.6	5.8	6.5	7.2		
Average Length		1.8	3.3	4.9	6.0	6.5	7.2		
Standard Deviation		0.28	0.17	0.22	0.33				
Number Averaged		44	41	26	10	5	5		

NOTE: Year classes with less than three fish samples are not included in average length or standard deviation calculations.

2008

Year Class	Number Aged	Back calculated length (inches) at each age							
		1	2	3	4	5	6	7	8
2007	4	2.2							
2006	12	1.9	3.2						
2005	13	1.6	2.9	4.6					
2004	7	1.4	2.7	4.1	5.1				
2003	8	1.5	2.8	4.1	5.7	6.7			
2002	3	1.8	3.2	5.0	6.3	6.8	7.4		
Average Length		1.7	3.0	4.4	5.6	6.7	7.4		
Standard Deviation		0.29	0.25	0.42	0.61	0.08			
Number Averaged		47	43	31	18	11	3		

APPENDIX 2. Age and growth tables for largemouth bass at Ball Lake, 1995, 1996, 2001, 2002, 2004, 2007 and 2008.

	Length (inches) at last annulus formation at each age							
Survey Year	1	2	3	4	5	6	7	8
1995	5.4	9.4	12.0	13.8	15.5	16.8	18.7	
1996	5.3	8.9	12.3	13.6	15.2	16.5		
2001	4.1	7.6	11.1	13.8	15.2	16.4	17.3	18.5
2002	4.9	8.1	11.6	13.9	15.7	17.3	18.4	19.8
2004	4.1	8.5	11.1	12.6	14.8	15.5		
2007	5.7	8.9	11.1	12.7	14.4	15.5	17.2	18.9
2008	3.6	8.3	11.0	13.1	14.0	15.6	17.0	18.2
Natural Lakes Average	3.5	6.9	9.5	11.6	13.4	14.7		

1995

Year Class	Number Aged	Back calculated length (inches) at each age							
		1	2	3	4	5	6	7	8
1994	35	5.4							
1993	39	4.2	9.4						
1992	27	4.0	8.5	12.0					
1991	26	2.8	7.4	11.3	13.8				
1990	23	2.9	7.8	11.8	14.2	15.5			
1989	6	3.7	8.5	12.2	14.5	15.8	16.8		
1988	4	3.6	8.1	12.4	15.1	16.9	17.9	18.7	
Average Length		3.9	8.3	11.7	14.1	15.7	17.2	18.7	
Standard Deviation		0.88	0.70	0.40	0.58	0.75	0.77		
Number Averaged		170	135	96	69	33	10	4	

1996

Year Class	Number Aged	Back calculated length (inches) at each age							
		1	2	3	4	5	6	7	8
1995	16	5.3							
1994	80	3.8	8.9						
1993	11	3.7	9.1	12.3					
1992	10	3.4	7.8	11.7	13.6				
1991	4	2.7	7.1	11.3	13.7	15.2			
1990	5	2.8	7.9	11.3	13.6	15.5	16.5		
Average Length		3.6	8.2	11.7	13.6	15.4	16.5		
Standard Deviation		0.86	0.74	0.41	0.05	0.15			
Number Averaged		117	101	21	10	9	5		

2001

Year Class	Number Aged	Back calculated length (inches) at each age							
		1	2	3	4	5	6	7	8
2000	31	4.1							
1999	69	4.0	7.6						
1998	53	3.6	8.0	11.1					
1997	36	3.8	7.7	11.9	13.8				
1996	20	3.9	8.1	11.3	13.5	15.2			
1995	15	3.8	7.6	11.2	13.7	15.4	16.4		
1994	8	4.2	8.4	11.7	13.9	15.3	16.5	17.3	
1993	2	4.5	9.0	12.4	14.5	16	17.1	17.8	18.5
Average Length		3.9	7.9	11.4	13.7	15.3	16.5	17.3	
Standard Deviation		0.19	0.32	0.35	0.14	0.09	0.03		
Number Averaged		234	203	134	81	45	25	10	2

2002

Year Class	Number Aged	Back calculated length (inches) at each age							
		1	2	3	4	5	6	7	8
2001	33	4.9							
2000	48	4.0	8.1						
1999	77	4.5	9.2	11.6					
1998	59	4.0	8.4	12.0	13.9				
1997	25	4.0	8.3	12.3	14.6	15.7			
1996	15	4.8	8.9	11.9	14.7	16.2	17.3		
1995	10	4.4	8.7	11.7	14.1	16.1	17.5	18.4	
1994	3	3.4	6.5	9.9	13.2	15.3	17.5	18.8	19.8
Average Length		4.3	8.3	11.6	14.1	15.8	17.5	18.6	19.8
Standard Deviation		0.48	0.89	0.84	0.60	0.42	0.12	0.25	
Number Averaged		270	237	189	112	53	28	13	3

2004

Year Class	Number Aged	Back calculated length (inches) at each age							
		1	2	3	4	5	6	7	8
2003	8	4.1							
2002	27	4.0	8.5						
2001	13	3.5	8.4	11.1					
2000	5	4.3	8.4	11.3	12.6				
1999	7	4.0	8.9	12.0	13.8	14.8			
1998	1	2.6	7.2	10.6	13.5	14.4	15.5		
Average Length		4.0	8.6	11.5	13.2	14.8			
Standard Deviation		0.27	0.26	0.47	0.85				
Number Averaged		61	53	26	13	8	1		

2007

Year Class	Number Aged	Back calculated length (inches) at each age							
		1	2	3	4	5	6	7	8
2006	10	5.7							
2005	48	4.3	8.9						
2004	27	3.7	8.2	11.1					
2003	25	3.7	8.2	11.2	12.7				
2002	31	4.0	8.5	11.5	13.3	14.4			
2001	28	3.9	8.3	11.3	13.2	14.5	15.5		
2000	9	4.4	8.6	11.7	14.0	15.3	16.3	17.2	
1999	1	3.1	6.6	11.2	12.9	15.3	16.4	18.0	18.9
Average Length		4.2	8.5	11.3	13.3	14.7	15.9	17.2	
Standard Deviation		0.71	0.25	0.23	0.55	0.49	0.56		
Number Averaged		179	169	121	94	69	38	10	1

2008

Year Class	Number Aged	Back calculated length (inches) at each age							
		1	2	3	4	5	6	7	8
2007	15	3.6							
2006	62	4.2	8.3						
2005	38	3.9	8.3	11.0					
2004	21	3.8	8.0	11.1	13.1				
2003	26	3.8	8.1	11.0	12.8	14.0			
2002	28	4.0	8.5	11.4	13.3	14.7	15.6		
2001	11	4.2	8.5	11.3	13.3	14.7	16.1	17.0	
2000	2	4.9	8.3	11.7	13.7	15.0	16.3	17.3	18.2
Average Length		4.0	8.3	11.1	13.1	14.4	15.8	17.0	
Standard Deviation		0.21	0.23	0.18	0.24	0.40	0.34		
Number Averaged		203	188	126	88	67	41	13	

NOTE: Year classes with less than three fish samples are not included in average length or standard deviation calculations.

APPENDIX 1. General survey data pages

LAKE SURVEY REPORT

Type of Survey: [ ] Initial Survey [X] Re-Survey

Lake Name	County	Date of survey (Month, day, year)
Ball Lake	14 E	June 9-12, 2008
Biologist's name		Date of approval (Month, day, year)
Neil D. Ledet and Larry A. Koza		

LOCATION

Quadrangle Name	Range	Section
Hamilton	14E	31 ,32
Township Name	Nearest Town	
36N	Hamilton, IN	

ACCESSIBILITY

State owned public access site	Privately owned public access site	Other access site
Off of CR 170E		

Surface acres	Maximum depth	Average depth	Acre feet	Water level	Extreme fluctuations
87	66	40	1,147	894.53	

Location of benchmark

INLETS

Name	Location	Origin
Fish Creek	Northwest	Perfect Lake
Unnamed	North	

OUTLETS

Name	Location
Fish Creek	East shore into Hamilton Lake

Water level control

POOL	ELEVATION (Feet MSL)	ACRES
TOP OF DAM		
TOP OF FLOOD CONTROL POOL		
TOP OF CONSERVATION POOL		
TOP OF MINIMUM POOL		
STREAMBED		

Bottom type

- [ ] Boulder
- [X] Gravel
- [X] Sand
- [ ] Muck
- [ ] Clay
- [ ] Marl

Watershed use

General farming and residential

Development of shoreline

90% of shorelin residential

Previous surveys and investigations

USGS Hydrographic Survey. 1960. IDNR Fisheries Surveys: Hudson, 1967, 1969; Peterson, 1972, 1978; Ledet, 1983, 1986, 1987, 1988, 1996, 2001, 2002, 2004.

SAMPLING EFFORT

ELECTROFISHING	Day hours: N/A		Night hours: 0.75		Total hours: 0.75
TRAP NETS	Number of traps: 1		Number of Lifts: 3		Total effort: 3
GILL NETS	Number of nets: 2		Number of Lifts: 3		Total effort: 6
ROTENONE	Gallons:	ppm:	Acre Feet Treated:	SHORELINE SEINING	Number of 100 Foot Seine Hauls:

PHYSICAL AND CHEMICAL CHARACTERISTICS

Color: Dark green	Turbidity: 12 Feet 6 Inches (SECCHI DISK)
Alkalinity (ppm)*: Surface: 188.8 Bottom: 171.6	pH: Surface: 9.2 Bottom: 9.0
Conductivity: 430 micromhos	Air temperature: ℉
Water chemistry GPS coordinates: N 41.53818	W 84.94693

TEMPERATURE AND DISSOLVED OXYGEN (D.O.)

DEPTH (FEET)	Degrees (℉)	D.O. (ppm)	DEPTH (FEET)	DEGREES (℉)	D.O. (ppm)	DEPTH (FEET)	DEGREES (℉)	D.O. (ppm)
SURFACE	77.1	8.3	36	42.9	2.6	72		
2	77.0	8.4	38	42.8	1.3	74		
4	76.9	8.6	40	42.7	0.5	76		
6	73.9	9.1	42	42.6	0.1	78		
8	72.8	9.0	44	42.5	0.1	80		
10	69.0	8.5	46	42.4	0.1	82		
12	64.7	7.1	48	42.4	0.1	84		
14	62.1	5.8	50	42.3	0.1	86		
16	59.2	4.1	52	42.2	0.1	88		
18	55.9	2.4	54	42.0	0.1	90		
20	51.7	0.9	56	41.9	0.1	92		
22	50.4	0.8	58	41.7	0.1	94		
24	47.8	0.8	60	41.6	0.1	96		
26	45.2	1.4	62	41.6	0.1	98		
28	44.0	3.0	64	41.5	0.1	100		
30	43.7	3.7	66					
32	43.4	3.7	68					
34	43.2	3.8	70					

COMMENTS

*ppm-parts per million

SPECIES AND RELATIVE ABUNDANCE OF FISHES COLLECTED BY NUMBER AND WEIGHT 2008					
*COMMON NAME OF FISH	NUMBER	PERCENT	LENGTH RANGE (inches)	WEIGHT (pounds)	PERCENT
Gizzard shad	317	57.1	9.2 - 13.4	117.36	47.3
Bluegill	109	19.6	2.3 - 7.8	13.87	5.6
Largemouth bass	56	10.1	4.5 - 18.8	65.58	26.4
Black crappie	17	3.1	6.8 - 13.6	10.27	4.1
White sucker	11	2.0	9.6 - 18.3	11.75	4.7
Rock bass	10	1.8	4.0 - 8.2	1.72	0.7
Pumpkinseed	8	1.4	4.0 - 6.2	0.86	0.3
Warmouth	5	0.9	5.0 - 8.2	1.29	0.5
Yellow perch	5	0.9	3.6 - 10.8	2.48	1.0
Green sunfish	3	0.5	4.1 - 5.8	0.26	0.1
Spotted sucker	3	0.5	11.1 - 13.3	2.30	0.9
Yellow bullhead	3	0.5	10.7 - 12.1	2.05	0.8
Black bullhead	2	0.4	8.4 - 9.0	0.76	0.3
Hybrid sunfish	2	0.4	5.3 - 6.5	0.31	0.1
Muskellunge	2	0.4	23.6 - 30.6	9.47	3.8
Common carp	1	0.2	26.2	7.74	3.1
Redear	1	0.2	6.5	0.20	0.1
Brook silverside	present				
Total (18 Species)	555			248.27	

*Common names of fishes recognized by the American Fisheries Society.

**Less than 0.1 percent

NUMBER, PERCENTAGE, WEIGHT, AND AGE OF GIZZARD SHAD									
TOTAL LENGTH (inches)	NUMBER COLLECTED	PERCENT OF FISH COLLECTED	AVERAGE WEIGHT (pounds)	AGE OF FISH	TOTAL LENGTH (inches)	NUMBER COLLECTED	PERCENT OF FISH COLLECTED	AVERAGE WEIGHT (pounds)	AGE OF FISH
1.0					19.0				
1.5					19.5				
2.0					20.0				
2.5					20.5				
3.0					21.0				
3.5					21.5				
4.0					22.0				
4.5					22.5				
5.0					23.0				
5.5					23.5				
6.0					24.0				
6.5					24.5				
7.0					25.0				
7.5					25.5				
8.0					26.0				
8.5					TOTAL	317			
9.0	18	5.7	0.24						
9.5	68	21.5	0.28						
10.0	81	25.6	0.33						
10.5	68	21.5	0.38						
11.0	40	12.6	0.44						
11.5	17	5.4	0.50						
12.0	14	4.4	0.56						
12.5	6	1.9	0.63						
13.0	5	1.6	0.71						
13.5									
14.0									
14.5									
15.0									
15.5									
16.0									
16.5									
17.0									
17.5									
18.0									
18.5									

ELECTROFISHING CATCH	214.7 /hr	GILL NET CATCH	20.8 /lift	TRAP NET CATCH	10.3 /lift

NUMBER, PERCENTAGE, WEIGHT, AND AGE OF BLUEGILL									
TOTAL LENGTH (inches)	NUMBER COLLECTED	PERCENT OF FISH COLLECTED	AVERAGE WEIGHT (pounds)	AGE OF FISH	TOTAL LENGTH (inches)	NUMBER COLLECTED	PERCENT OF FISH COLLECTED	AVERAGE WEIGHT (pounds)	AGE OF FISH
1.0					19.0				
1.5					19.5				
2.0	2	1.8	0.01	1	20.0				
2.5	2	1.8	0.02	1	20.5				
3.0	3	2.8	0.03	2	21.0				
3.5	13	11.9	0.04	2	21.5				
4.0	9	8.3	0.05	2,3	22.0				
4.5	10	9.2	0.07	3	22.5				
5.0	21	19.3	0.10	4	23.0				
5.5	16	14.7	0.13	3	23.5				
6.0	11	10.1	0.18	3,4	24.0				
6.5	9	8.3	0.23	4,5	24.5				
7.0	8	7.3	0.27	5	25.0				
7.5	5	4.6	0.33	5,6	25.5				
8.0					26.0				
8.5					TOTAL	109			
9.0									
9.5									
10.0									
10.5									
11.0									
11.5									
12.0									
12.5									
13.0									
13.5									
14.0									
14.5									
15.0									
15.5									
16.0									
16.5									
17.0									
17.5									
18.0									
18.5									

ELECTROFISHING CATCH	49.3 /hr	GILL NET CATCH	4.3 /lift	TRAP NET CATCH	15.3 /lift

NUMBER, PERCENTAGE, WEIGHT, AND AGE OF LARGEMOUTH BASS									
TOTAL LENGTH (inches)	NUMBER COLLECTED	PERCENT OF FISH COLLECTED	AVERAGE WEIGHT (pounds)	AGE OF FISH	TOTAL LENGTH (inches)	NUMBER COLLECTED	PERCENT OF FISH COLLECTED	AVERAGE WEIGHT (pounds)	AGE OF FISH
1.0					19.0				
1.5					19.5				
2.0					20.0				
2.5					20.5				
3.0					21.0				
3.5					21.5				
4.0					22.0				
4.5	3	5.4	0.05	1,2	22.5				
5.0	1	1.8	0.07	1	23.0				
5.5	2	3.6	0.09	1,2	23.5				
6.0	1	1.8	0.12	1	24.0				
6.5					24.5				
7.0	1	1.8	0.17	3	25.0				
7.5	2	3.6	0.21	2,3	25.5				
8.0					26.0				
8.5					TOTAL	56			
9.0	2	3.6	0.37	2,3					
9.5	4	7.1	0.43	2,3					
10.0	1	1.8	0.49	3					
10.5	2	3.6	0.60	2,3					
11.0	2	3.6	0.67	3,4					
11.5									
12.0	4	7.1	0.89	3,4					
12.5	2	3.6	1.04	3,4					
13.0	4	7.1	1.14	4,5					
13.5	4	7.1	1.28	4,5					
14.0	4	7.1	1.42	4,5					
14.5	4	7.1	1.59	4,5,6					
15.0	5	8.9	1.74	5,6					
15.5									
16.0	1	1.8	2.14	6					
16.5	1	1.8	2.35	7					
17.0	1	1.8	2.66	7					
17.5	1	1.8	2.80	7					
18.0	1	1.8	3.05	8					
18.5	3	5.4	3.31	7,8					

ELECTROFISHING CATCH	69.3 /hr	GILL NET CATCH	0.7 /lift	TRAP NET CATCH	/lift

GPS SAMPLING COORDINATES

GILL NETS				TRAP NETS				ELECTROFISHING			
1	N 41.53651	W 84.93880		1	N 41.53585	W 84.94157		1	N	W	
	N	W		2	N 41.53649	W 84.94432			N	W	
2	N 41.54009	W 84.95295		3	N 41.53997	W 84.95412		2	N	W	
	N	W		4	N	W			N	W	
3	N 41.53591	W 84.94146		5	N	W		3	N	W	
	N	W		6	N	W			N	W	
4	N 41.53963	W 84.95175		7	N	W		4	N	W	
	N	W		8	N	W			N	W	
5	N 41.53703	W 84.94809		9	N	W		5	N	W	
	N	W		10	N	W			N	W	
6	N 41.53905	W 84.94514		11	N	W		6	N	W	
	N	W		12	N	W			N	W	
7	N	W		13	N	W		7	N	W	
	N	W		14	N	W			N	W	
8	N	W		15	N	W		8	N	W	
	N	W		16	N	W			N	W	
9	N	W		17	N	W		9	N	W	
	N	W		18	N	W			N	W	
10	N	W		19	N	W		10	N	W	
	N	W		20	N	W			N	W	
11	N	W						11	N	W	
	N	W							N	W	
12	N	W						12	N	W	
	N	W							N	W	
13	N	W						13	N	W	
	N	W							N	W	
14	N	W						14	N	W	
	N	W							N	W	
15	N	W						15	N	W	
	N	W							N	W	
16	N	W						16	N	W	
	N	W							N	W	
17	N	W						17	N	W	
	N	W							N	W	
18	N	W						18	N	W	
	N	W							N	W	
19	N	W						19	N	W	
	N	W							N	W	
20	N	W						20	N	W	
	N	W							N	W	

Occurrence and Abundance of Submersed Aquatic Plants

Lake:	Ball Lake	Secchi(ft):	8.0	SE Mean species / site:	0.16
Date:	7/14/2008	Littoral sites with plants:	39	Mean natives / site:	1.23
Littoral Depth (ft):	10.0	Number of species:	7	SE Mean natives / site:	0.14
Littoral Sites:	40	Maximum species / site:	4	Species diversity:	0.75
Total Sites:	40	Mean species / site:	2.10	Native diversity:	0.78

	Frequency of	Score Frequency				
Species	**Occurrence**	**0**	**1**	**3**	**5**	**Dominance**
Eurasian watermilfoil	87.5	12.5	27.5	25.0	35.0	55.5
Coontail	42.5	57.5	30.0	5.0	7.5	16.5
Slender naiad	30.0	70.0	27.5	2.5	0.0	7
Small pondweed	15.0	85.0	15.0	0.0	0.0	3
Chara	12.5	90.0	7.5	2.5	0.0	4
Variable pondweed	12.5	87.5	12.5	0.0	0.0	2.5
Water stargrass	10.0	90.0	10.0	0.0	0.0	2

Other species noted: White waterlily, cattail, sago pondweed, spatterdock and pickerelweed